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PATENT- OG VAREMÆRKESTYRELSEN

A VALVE FOR PRESSURE REDUCTION

Field of the invention

The present invention relates to a pressure-reducing valve for installation in connection with a gas-conveying conduit. In general, the valve according to the present invention is adapted to significantly reduce the conveyed gas pressure by splitting a supplied stream of gas into more streams of gas. In particular, the invention relates to a pressure-reducing valve for nasal continuous positive airway pressure (CPAP) treatment.

Background of the invention

CPAP is an airway treatment wherein a slight positive air pressure is applied to the respiratory organs of a patient in order to increase the volume of inhaled air and thus, to decrease the work of breathing. CPAP treatment is given through a set of nasal prongs, through a mask or through a ventilation tube fixed in the trachea. Often, neonates, in particular premature babies, are given CPAP treatment in order to relieve the respiratory organs. Moreover, CPAP treatment is applied for the alleviation of snoring and obstructive sleep apnea. The applied air pressure should typically not exceed the equivalence of a 2-7 cm water column and the applied amount of air should not exceed the range of 5-7 litres per minute. Standard gas supplies are normally adapted to deliver gas of a much higher pressure and quantity and therefore a reduction valve is inserted between the gas supply and the CPAP treating device.

In general, valves for reducing air pressure and delivered air quantities, e.g. in connection with CPAP treatment, exist. Typically, a supplied stream of air, e.g. air supplied with 6-7 bar overpressure, is split into more streams of air. One of the streams is guided through one outlet to respiratory means, e.g. a set of nasal prongs or to a mask, and thus to the respiratory organs of the treated individual. The excess stream or streams of air is/are guided through other outlets to the ambient atmosphere. By splitting the 6-7 bar over-pressurised stream of air into several streams of air, the pressure and quantity of air guided to the respiratory means can be reduced significantly compared with the supplied air pressure. Due to its simple and yet highly reliable structure, this type of pressure reducing valve is appreciated not least for medical purposes such as CPAP treatment. It is however often experienced that the excess stream or streams of air emitted from the valve may cause an uncomfortable cooling and drying effect for the treated individual and during longer treatment cycles, complications deriving from the cooling and drying may occur.

Description of the invention

It is an object of the present invention to overcome the above-described disadvantages of the known pressure-reducing valves by providing a tubular air supply device defining an inner cavity therein and comprising a high pressure air inlet

end part, an opposite low pressure air outlet end part, an intermediate air venting part for venting air from the inner cavity into the ambient atmosphere and air flow deflecting means for directing air flows from the air venting part towards the air inlet end.

Due to the arrangement of the gas-emitting outlets, an excess stream of air, i.e. a stream of air passing through the air venting part, is guided in a direction opposite the direction of the stream of air which is used for the treatment, i.e. the stream which is guided to the respiratory tract. Accordingly, the valve supports an arrangement wherein one stream of air is guided in one direction e.g. to a set of nasal prongs and other streams of air is blown in a direction facing away from this direction. Upon suitable fitting of the device with respect to nasal prongs etc., the air from the air venting part is blown in a direction facing away from the individual receiving the treatment. The valve is, at one end, connected to the gas-conveying conduit supplying pressurised gas. From this end, the supplied gas is split into a first flow of gas conveyed to the low pressure outlet and a second flow of gas conveyed to the ambient atmosphere, the two gas-flows being directed in opposite directions, or, at least the second flow of gas is directed in the direction towards the high pressure air inlet.

As an example, the valve may be provided in the form of an annular or tubular body defining a conduit between a high pressure air inlet and a low pressure air outlet. Between the high pressure air inlet and the low pressure air outlet, one or more air venting parts, i.e. parts for venting air to the ambient atmosphere may be defined. The air venting part or parts may be provided in the form of perforation of the wall of the tubular body, e.g. in the form of one or more through-going holes, i.e. holes extending from the conduit to an exterior surface of the annular or tubular body. On the exterior surface of the body, the gas flowing through the air venting part(s) is guided in a direction towards the high pressure air inlet. The through-going holes, i.e. the air venting part may extend radially from the conduit and may be provided, e.g. by drilling one or more holes in the side wall of the tubular body. As an example, the hole(s) may be drilled throughout the side wall so that a first part of the supplied gas can flow through the conduit from the high pressure air inlet to the low pressure air outlet, e.g. to nasal prongs while a second part of the supplied gas can flow through the through-going holes to the ambient atmosphere. At the point where the through-going holes reaches the outer surface of the tubular body, the flow of the second part of the supplied gas is turned into a direction opposite the direction of the first flow direction. As an example, the tubular body may be provided with a sleeve or cuff, surrounding the air venting part and defining a space between the outer peripheral surface of the air venting part and the inner peripheral surface of the sleeve or cuff. The space may then be closed at a first end opposing the air outlet end part and open at an opposite second end part opposing the air inlet end. The sleeve or cuff thus in co-operation with the tubular body forms a flow channel for the air being released to the ambient atmosphere. As an example, the sleeve or cuff may be a tubular, hollow

body with an internal diameter or clearance, which exceeds the external diameter of the tubular body so that a circular flow passage is defined therein between. In one end, the cap seals against the outer surface of the tubular body towards the outlet end thereof. In the other end, the passage defined between the inner surface of the cap and the outer surface of the tubular body is open to the ambient atmosphere. Accordingly, gas entering through the through-going holes is guided through the circular flow passage from which passage it can only escape in a direction opposite the low pressure air outlet of the valve, i.e. in a direction facing away from the individual.

According to a preferred embodiment of the invention, the air outlet part, and the intermediate air venting part form an integral unit, e.g. a one piece moulded piece which could be a tubular body of revolution. A particularly cost efficient valve may be made from two individually pressure-moulded plastics or metallic parts. A first of the parts is an inner tubular body with a bore extending longitudinally between the high pressure air inlet and the low pressure air outlet. The tubular body being provided with a number of through-going radially extending holes, i.e. holes extending perpendicularly to the first flow passage. A second of the parts is an outer tubular cap. The sleeve or cuff part is adapted in one end to seal against the outer surface of the tubular body whereas the other end is provided with a radial size allowing gas to escape between an inner surface of the cap and an outer surface of the body, when the cap is attached to the body.

The perforated area of the device may extend throughout or substantially throughout the inner cavity of the device, thus making the air venting part adapted to vent the major part of the air flowing through the inner cavity of the device.

Moreover, the inner cavity and the air vents of the air venting part could be shaped and dimensioned so as to reduce the air inlet pressure from an overpressure of several bars to an overpressure of a fraction of a bar. In particular, the dimensions of the high pressure inlet, the low pressure outlet, the air venting part and the perforations should be selected so that the air inlet pressure is reduced from the regular gas pressure supplies, i.e. normally 5-7 bar overpressure to the equivalence of 2-7 cm water column overpressure.

It may be an advantage to provide the sleeve or cuff as a separate part attached to the integral unit, not least in order to allow inspection of the venting part for ensuring that the perforation is not blocked.

When the integral unit forms an external peripheral portion with a stepped configuration or with a flange, the sleeve or cuff may easily be positioned on the integral unit by sliding the sleeve or cuff onto the integral unit until it engages a step or the flange of the peripheral portion of the integral unit. In order to make the joint between the integral unit and the sleeve or cuff at least substantially airtight, the

joined edges of at least one of the two parts may be provided with a surface with sealing characteristics. As an example, the inner surface of the sleeve or cuff part may thus be provided with a soft and resilient material, e.g. provided on a circumferentially and radially inwardly extending flange adapted to seal against the outer surface of the integral unit. Alternatively, the outer surface of the integral unit may be provided with such a material at least in the step or on the flange.

In order to support easy fitting of the device for use in CPAP treatment or for treatment of sleep apnea or for similar treatment, the low pressure air outlet may be provided with a flange for connecting a nasal prong section. Alternatively, the low pressure air outlet may simply be formed as a set of nasal prongs allowing the air supply device to be inserted directly into the nostrils.

During CPAP treatment, the pressure reducing valve must be worn by the treated individual in relatively close vicinity to the respiratory organs. Accordingly, the weight of the valve is important for the well-being of the treated individual. Accordingly, the valve may preferably be made from a plastic material such as a thermoplast. In order to reduce the manufacturing costs, the valve may be made in one or two pieces by injection moulding.

According to another aspect, the present invention relates to a method of providing gas to a CPAP valve, said method comprising conveying gas under pressure from a gas supply to at least two gas conveying passages, one passage extending towards an outlet in a first direction and the other passage extending towards an outlet in a direction oppositely in relation to the first direction.

Detailed description of the invention

A preferred embodiment of the invention will now be described in details with reference to the drawing in which:

Fig. 1 shows a side view of a first part of a valve according to the present invention,

Fig. 2 shows the first part of Fig. 1, seen from the high pressure air inlet,

Fig. 3 shows a side view of a second part of a valve according to the present invention,

Fig. 4 shows the second part of Fig. 3, seen from an end thereof, which, when attached to the first part, is towards the high pressure air inlet,

Fig. 5 shows a perspective view of a valve according to the present invention, and

Fig. 6 shows another perspective view of the valve of Fig. 5.

As shown in Fig. 1, a first part of a valve according to the present invention is an integral unit comprising an oblong tubular body 1 provided with an internal flow passage 2. In Fig. 1, the passage is symbolised by the to dotted lines 5. The flow passage extends from a high pressure air inlet 3 to a low pressure air outlet 4. Intermediate between the inlet and the outlet, an air venting part is formed by perforation of the tubular body. In Fig. 1, the perforation is formed as 2 radially, throughout extending bore holes 6 allowing air to escape from the internal flow passage to the ambient atmosphere (one of the bore holes is symbolised by the dotted lines 7).

As shown in Fig. 1, the oblong tubular body 1 may preferably have a stepped configuration with sections 8, 9, 10 and 11 having different external cross sectional sizes or diameters. Likewise, the flow passage may be split into sections having different cross-sectional sizes or diameters. At the high pressure inlet and/or at the low pressure air outlet, one or more resilient o-rings 20 may support air tight connection between the integral unit and an air-supply hose and/or nasal prongs, respectively.

In Fig. 2, it is seen that the integral unit is a tubular body of revolution.

In Fig. 3, flow defecting means in the form of a second part 12, i.e. a sleeve or cuff part of the valve, is shown. The second part is provided with an elongated body having a pair of axially spaced, opposed ends 13,14. At one end 13, the second part is adapted to seal along an outer surface of the integral unit part. At the other end 14 the second part in combination with the integral unit, forms an outlet for the gas flowing through the air venting parts. The surface part 19 is adapted to slide against the surface part 17 of the integral unit until the surface part 18 abuts against the surface part 16 of the integral unit.

The stepped configuration of the external surface of the integral unit will allow the second part to be positioned easily on to the integral unit. As an example, one section of the first part may be provided with an external diameter allowing one section of the second part to be attached in a gas sealing engagement. Another section may be provided with a larger external diameter thus preventing the second part to slide over this section.

Fig. 5 shows a perspective view wherein the second part is attached to the first part.

Fig. 6 shows another perspective view wherein the passage defined between the integral unit and the second part is shown. As shown, air entering through the high

pressure air inlet 3 may flow in a substantially linear flow direction towards the low pressure air outlet 4, to which end nasal prongs or similar means for leading a flow of gas to the nostrils of a treated subject may be attached. Alternatively, nasal prongs may be an integrated part of the low pressure air outlet 4. Intermediate the two ends, a venting part may lead gas to the ambient atmosphere, which gas, by the second part 12 will be directed in a direction towards the high pressure gas inlet 3. In a preferred embodiment, the device is provided with connecting flanges in one or both of the low and high pressure ends. The connecting flanges may e.g. be provided with one or more circumferentially extending protrusions, e.g. in the form of one or more O-shaped rubber rings. The high pressure end may be coloured in one colour and the low pressure end in another colour, thus allowing easy and safe orientation of the device during the assembly with the gas supplies and the respiratory means. In Fig. 6, the flow channel 15 defined between the integral unit or oblong body 1 and the second part 12, is clearly seen. The channel directs the air released via the air venting part from the inner cavity to the ambient atmosphere, in a direction opposite the direction of the low pressure air outlet.

Claims

1. A tubular air supply device defining an inner cavity therein and comprising a high pressure air inlet end part, an opposite low pressure air outlet end part, an intermediate air venting part for venting air from the inner cavity into the ambient atmosphere and air flow deflecting means for directing air flows from the air venting part towards the air inlet end.

2. A device according to claim 1, wherein the air venting part is a perforated wall part.

3. A device according to claim 2, wherein the perforated wall part is an annular wall part.

4. A device according to any of the claims 1-3, wherein the air flow deflecting means comprise a sleeve or cuff surrounding the air venting part and defining a space between the outer peripheral surface of the air venting part and the inner peripheral surface of the sleeve or cuff, said space being closed at a first end opposing the air outlet end part and open at an opposite second end part opposing the air inlet end.

5. A device according to any of the claims 1-4, wherein the air inlet part, the air outlet part, and the intermediate air venting part form an integral unit.

6. A device according to claim 5, wherein the integral unit is a tubular body of revolution.

7. A device according to any of the claims 1-6, wherein the inner cavity and the air vents of the air venting part are shaped and dimensioned so as to reduce the air inlet pressure from an overpressure of several bars to an overpressure of a fraction of a bar.

8. A device according to any of the claims 1-7, wherein the air venting part is adapted to vent the major part of the air flowing through the inner cavity of the device.

9. A device according to any of the claims 5-8, wherein the sleeve or cuff is a separate part attached to the integral unit.

10. A device according to claim 9, wherein the integral unit forms an external peripheral portion intermediate the high pressure air inlet end part and the low

pressure air outlet, said external peripheral portion comprising a stepped configuration or a flange adapted to position the sleeve or cuff.

11. A device according to claim 10, wherein the sleeve or cuff part comprises an internal peripheral portion with a first section and a second section, the radial size of the first section being larger than the largest radial size of the integral unit whereas the radial size of the second section being smaller than the radial size of the largest radial size of the integral unit.

12. A device according to any of the preceding claims, wherein the low pressure air outlet is adapted with a flange for connecting a nasal prong section.

13. A device according to any of the preceding claims, wherein the low pressure air outlet is constituted by a nasal prong section having first and second nasal prong gas outlets.

14. A device according to any of claims 9-13, wherein the sleeve or cuff part is a tubular body of revolution.

15. A method of providing gas to a CPAP valve, said method comprising conveying gas under pressure from a gas supply to at least two gas conveying passages, one passage extending towards an outlet in a first direction and the other passage extending towards an outlet in an opposite direction.

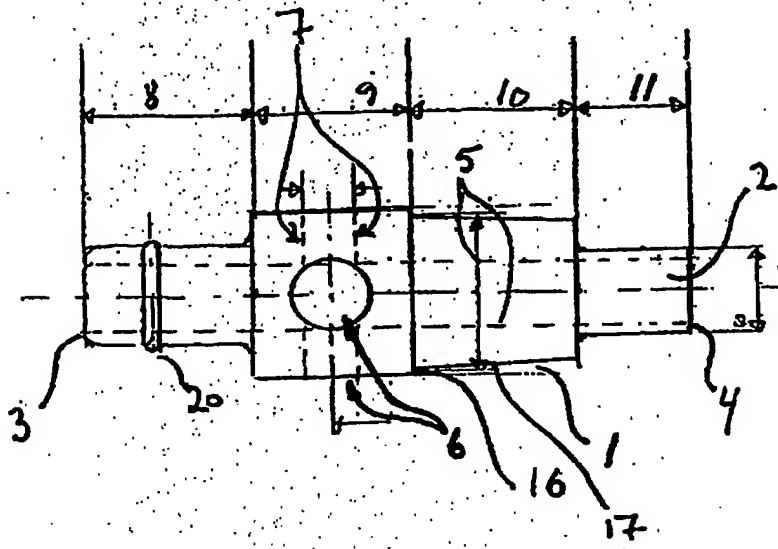

Fig. 1

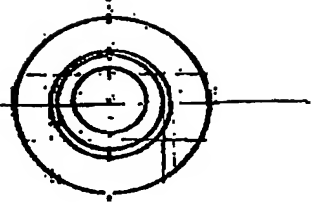

Fig. 2

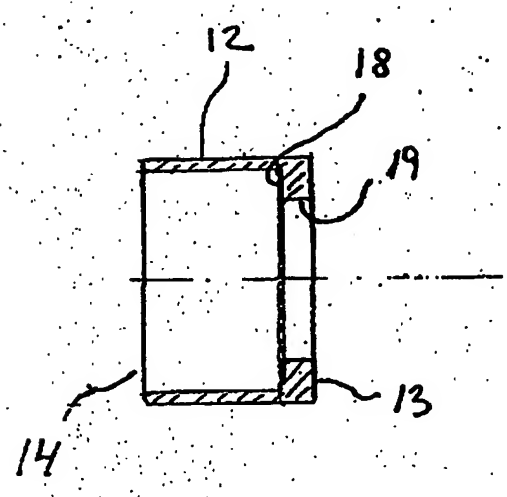

Fig. 3

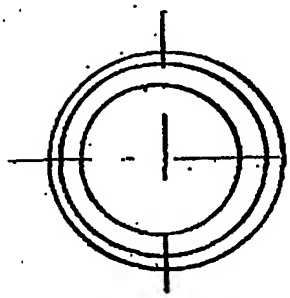

Fig. 4

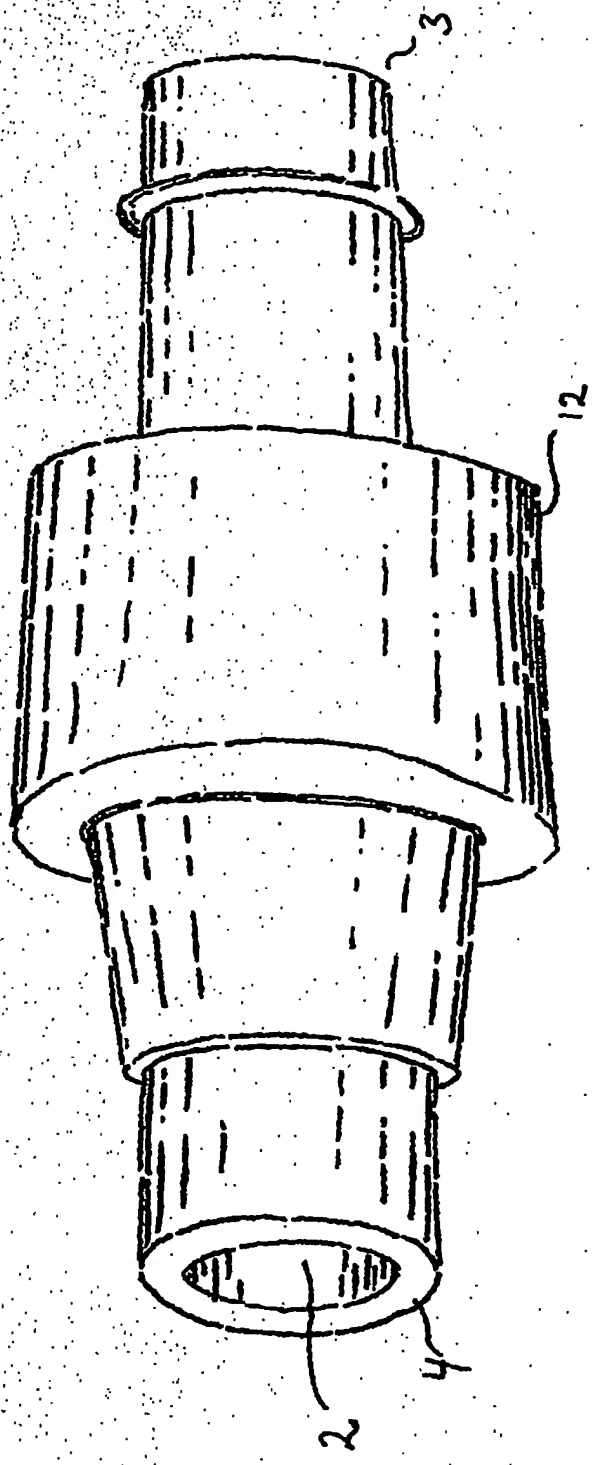

Fig. 5

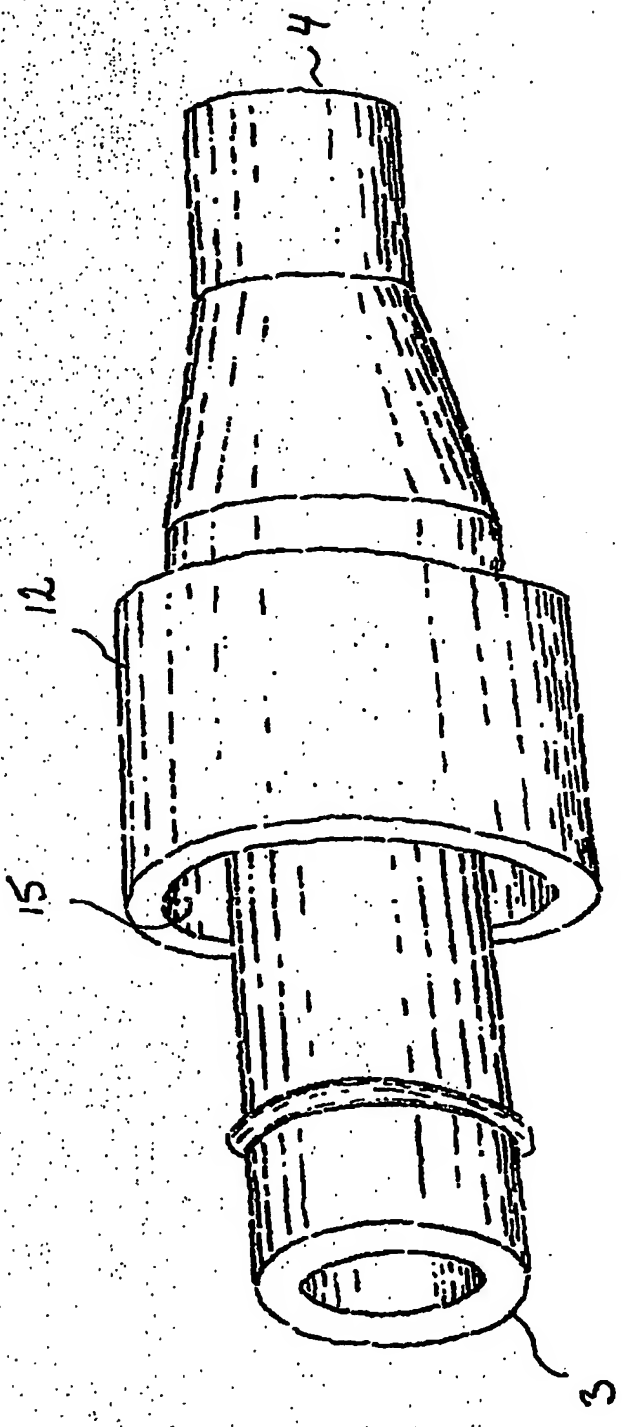

Fig. 6